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THE FRENCH WEAPON ACQUISITION PROCESS

James W. Sterling

Army Foreign Science and Technology Center
Charlottesville, Virginia

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20. ABSTRACT

The characteristics of the French weapon acquisition process reflect the national policy of self-sufficiency in defense matters, severe resource constraints, limited domestic weapons market, and the unique characteristics of the French political and industrial system. Past studies were summarized which described the apparent high degree of efficiency achieved by the French aerospace industry - specifically, the firm of Dassault. Small, stable design teams and incremental developmental philosophy were two of the factors defined as the source of the unusual Dassault efficiency. Indicators of this efficiency in the R&D process were also found in other weapon areas. The study describes the organization and activities of the Delegation Ministerielle Pour l'Armement (DMA), the centralized organization formed to consolidate all weapon procurement activities of the three services. It also describes the career pattern and use of the Corps of Armaments Engineers, the military-technical managers who occupy the key management positions in French weapons acquisition. A detailed weapon life cycle model is provided which depicts the methods used to generate pragmatic requirements and reduce uncertainty and costs while producing responsive weapon development programs. An analysis of DMA in-house activities as well as the general characteristics of the defense industry is presented. Government consolidation of the French defense industry (to reduce duplication) is shown to have virtually eliminated competition other than that experienced in international weapons sales. Firm government (i.e., DMA) control of all defense activities (in-house, nationalized, and private) is noted; yet, DMA and its supervised defense activities function more as partners than as mutual adversaries. (U)

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PREFACE

This paper was prepared at the request of the Army Materiel Acquisition Review Committee. It analyzes the salient features of the French weapon acquisition process vis-a-vis the United States and other major European countries. The Foreign Science and Technology Center has conducted studies of the USSR, PRC, and US (the latter for comparative purposes) weapon acquisition processes and has thereby gained some awareness of the major issues involved. The French weapon acquisition process, however, has not been a subject of prior study and no data base or special expertise was immediately available. The study has therefore been synthesized from those data sources which could be collected and analyzed in the limited time available.

Constructive criticisms, comments, or suggested changes are encouraged, and should be forwarded to the US Army Foreign Science and Technology Center, Charlottesville, VA 22901 ATTN: AMXST-PO).

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Past studies are summarized which describe the apparent high degree of efficiency achieved by the French aerospace industry specifically, the firm of Dassault. Small, stable design teams and incremental developmental philosophy were two of the factors defined as the source of the unusual Dassault efficiency. Indicators of this efficiency in the R&D process were also found in other weapon areas.

The study describes the organization and activities of the Delegation Ministerielle Pour l'Armement DMA , the centralized organization formed to consolidate all weapon procurement activities of the three services. It also describes the career pattern and use of the Corps of Armament Engineers, the military technical managers who occupy the key management positions in French weapon acquisition.

A detailed weapon life cycle model is provided which depicts the methods used to generate pragmatic requirements and reduce uncertainty and costs while producing responsive weapon development programs.

An analysis of DMA in house activities as well as the general characteristics of the defense industry is presented. Government consolidation of the French defense industry to reduce duplication is shown to have virtually eliminated competition other than that experienced in international weapon sales. Firm government i.e., DMA control of all defense activities in-house, nationalized, and private is noted; yet, DMA and its supervised defense activities function more as partners than as adversaries.

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Section I.

COMPARATIVE ANALYSIS OF FRENCH MILITARY RESEARCH AND DEVELOPMENT EXPENDITURES

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1. Introduction

Before beginning an analysis of the French weapon acquisition process, it appears advisable to set the stage by developing a brief analysis of the quantity of resources allocated by the French government to defense and to military research and development (R&D) vis-a-vis similar expenditures by other major countries. These expenditure levels, along with other factors (e.g., national policies toward political independence, use of military materiel for foreign trade purposes, extent of government control of industry, etc.), establish unique constraints which shape each nation's military R&D strategy and the resulting weapon acquisition process.

2. Foreign Military R&D Expenditures

a. The expenditure data used in sections I and II are derived from the Stockholm International Peace Research Institute (SIPRI*) publication, "Resources Devoted to Military Research and Development."[1]

b. Table I shows the level of military R&D expenditures in selected non-communist countries for 1970 and average expenditures for the period from 1967 to 1970. As can be seen, the French and United Kingdom expenditures are quite similar; however, the US average is 14.5 times as large as the French average. After adjusting for international differences in wages, the US average is 11.3 times as large as the French.

c. Table II presents, for the year 1967 and for the same countries, the following data: military R&D expenditure; total military expenditure; and military R&D expenditure as a percentage of gross national product (GNP), total military expenditure and total government R&D expenditure. The US military expenditure is 14 times as large as the French expenditure and the percentage of GNP allocated to military R&D is almost twice as large for the United States as for France. The percentage of total military expenditure allocated to military R&D is very similar. France also allocated a smaller share of total

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*See List of Abbreviations page 61.

Table I. Levels of Military Research and Development Expenditure

Countries ranked by level of average annual expenditure 1967-70	Average annual expenditure, 1967-70	Expenditure, 1970	Average annual expenditure 1967-70, at approximate R&D exchange rates[c]
United States -----	8,708.9	8,608.6	8,708.9
France ----------	601.6	536.7	770.8
United Kingdom ----	583.3	544.8	859.6
FR Germany --------	271.0	314.2	352.3
Sweden ----------	92.6	74.4	106.4
Italy ----------	22.4	30.5	33.1
Japan ----------	20.8[a]	25.3[b]	52.8[a]
India ----------	18.8	24.4	62.0

[a]1966-69.

[b]1969.

[c]The use of special exchange rates is intended to allow for international differences in the cost of R&D input. The rates used here, which are based on manpower and expenditure data for R&D performed by business enterprises, make some allowance for international differences in the wages of R&D employees. They are not specific to military R&D and do not allow for international differences in the price of R&D facilities and equipment, or in productivity.

Table II. Military R&D Expenditure as a Share of GNP, Total Military Expenditure, and Total Government R&D Expenditure (1967)

Countries ranked by level of military R&D expenditure	$US millions, at 1967 prices and official exchange rates		Military R&D expenditure as a percentage of:		
	Military R&D expenditure	Total military expenditure	GNP	Total military expenditure	Total government R&D expenditure
United States ----	8,952.0	80,517.0	1.06	11.1	52.6
United Kingdom ---	636.2	6,044.9	0.59	10.5	46.6
France ----------	627.9	5,856.1	0.54	10.7	35.1
FR Germany -------	255.8	5,352.0	0.21	4.8	21.3
Sweden ----------	110.6	1,004.0	0.44	11.0	44.2
Italy ----------	21.5	2,174.4	0.03	1.0	7.5
Japan ----------	18.1	1,075.0	0.02	1.7	3.9
India[a] ----------	16.7	1,291.2	0.04	1.2	11.8

[a]1968.

government R&D expenditures to military R&D. Not shown in table II, but worth noting, is the percentage of GNP allocated to total military expenditures. In 1967, this percentage figure was approximately 9.5% and 5%, respectively for the United States and France, or approximately 2:1. This ratio has continued in recent years as each country has allocated a declining share of GNP. In France, the current and projected share of GNP allocated to total military expenditures is only slightly higher than 3%.

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Section II.

APPARENT MILITARY R&D STRATEGY OF FRANCE

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1. National Policy and Resource Constraints

As established by General de Gaulle, the French national defense policy is one of political independence and self-sufficiency in the development of an autonomous, all-encompassing defense system. That is, France has chosen to rely on no other country for provision of its needed weapon systems. As shown in section I, however, the resources allocated to their defense effort has been relatively small, measured either as a percentage of GNP or relative to the US dollar amount, which is approximately 14 times as large. This desire for self-sufficiency, within resource limitations establishes a severe cost constraint, which is a major determinant of their weapon acquisition process. Where trade offs are required between costs and other factors, cost is given great emphasis.

2. Possible R&D Strategies with Varying Resource Constraints

a. SIPRI[1] noted that major countries normally spend from 30% to 45% of their total defense dollars for weapon procurement in recent years. France has spent 45% to 50% for procurement. This fractional share for procurement times the total defense budget defines the domestic market for weapon systems. Each country must develop an appropriate strategy regarding weapon importation versus domestic development. SIPRI notes a defense expenditure threshold of between 2 to 4 billion dollars, below which a country must generally import all or most of its weapon systems. Only the USSR and the United States have the resources to develop a variety of weapon systems for all mission areas. Countries at or slightly above this threshold pursue a mixed strategy, with some importation and minimization of the number of systems required for development. The apparent procurement strategies for the eight countries presented in tables I and II as well as for the USSR and the PRC are shown in table III which summarizes the development programs of those countries undertaken in the period 1960 to 1968.

b. The French domestic weapon development program as revealed by table III and other supporting information has the following characteristics:

Table III. Survey of Government-Financed Weapon Development Projects Under Way 1960–1968[a]

Coding Explanation:
1 = number of new versions of weapon systems under development.
1' = number of modified versions of existing systems under development.
1'' = number of modified versions of foreign-designed systems under development.

Countries by level of mil. expen.	1960-68 av. an. (US$ millions)		Nucl. test expl. 60-68	Missile systems						Armo veh.		Military aircraft and aeroengines								Naval ships			
				A-S	Anti-land based target, range:			Anti-air.	Anti-tank, anti-ship	Main bat. tank	Other	Aeroengines		Fighter, jet tr.		Bomber, transp.	Hel., VTOL	Light plane	Drone	Submarine		Conv. ships	Air.-car.	Other displ. over 1000 t.
	Tot. mil. expen.	Mil. R&D expen.			long	int.	med.-sh.					jet	other	Sup. Son.	Sub. Son.					Nucl.-pow.				
USA	over	7955	286	2	6 1'	3 1'	11 2'	7 21'	4	1 b	11 b	11 24'	9 25'	4 25'	4 12'	8 54'	31 8'	12 5'	4 2''	4 11'		4 11'	5 11'	10 14'
USSR[c]	35,000	---	129	1		3	8	6	5	1 b	4 b	b b	b b	7 12'		8 14'	6 1'	3	b b	1 2'		2 4'	1	4 5'
UK		705	4				2	7 7'	2 1''	1 b	2 b	12 4'	1 7'	5 9'	2 4'	7 11'	13 7'	3 4'	1	4			2 4'	4 4'
France	4500 to 5500	465	24		2		7	5	5	1	2 b	7 3'	9 12'	6 5'	2'	4 3'	5 1'	3 2'	2	3 2'		2	3 11'	5 2'
FRG		175						1	3	2	5 b	2 1'	4 10'	1	1	2	5 2'	3 2'	2			1'		2''
China		---	3		1							1 1'		1										1
Sweden		80					1	1	3	1	2 1'	1''		1 5	1 2			3 1				2 1'		2'
India	700 to 1000	15								1''														
Japan[d]	1900	15					1	2	1			1		1		3 6	4'	2 6'	1			2	2 1'	3 1'
Italy		15						1''							2	1 1''	2 2''	3 1''	2			1	2	1 3'

[a] Projects underway at least one year which were carried through prototype construction by 1968 or programmed for prototype by 1970. Joint projects are counted under each main country.

[b] Versions under development but data insufficient for accurate count.

[c] Due to lack of official data, figures given for USSR are less reliable. Each observed missile system is reported as a new system due to lack of data regarding product modifications.

[d] Japan completed a main battle tank, a light tank, and an armored car shortly before the period under study.

SOURCE: SIPRI (Reference 1)

1. Major strategic weapons have been omitted such as ABM systems, long range bombers, and advanced long-range missile systems. There are obvious geopolitical as well as economic reasons for these omissions.

2. The variety of weapon systems is much smaller. For example, France has 10 combat aircraft types in its air force compared to 8 for Britain, 3 for Sweden, and roughly 30 and 25 for the United States and the USSR, respectively.[2]

3. Operation at the "technological frontier" established by the two major powers is done in selected areas of strength, e.g., supersonic aircraft, certain missile systems (such as low altitude air defense systems), and helicopters. Varying degrees of lag are noted in other system areas (e.g., the nuclear weapons being developed by France are comparable to those developed in the United States in the late 1950's and early 1960's.[1]

3. Current Weapon Development Program

J. Blancard, former Minister of DMA, in 1971 summarized[10] the more recent important DMA developmental efforts as follows.

a. **Strategic Atomic Force.** *Sea trials of Le Redoutable*, the first nuclear missile submarine (SSBN), in July 1969 which then awaited her missile complement (16 surface-to-surface ballistic missiles); launch of *Le Terrible* in June 1969 with *Le Foudroyant* scheduled for launch by the end of 1971; manufacture and delivery of the first SSBM warheads for the French Air Force and experimentation for the Navy SSBM warheads, together with research on thermonuclear warheads (8 firings in the Pacific in 1970); completion of the silos of the first SSBM unit on the Plateau d'Albion; test and perfection of army, navy, and air force strategic missiles.

b. **Land Forces.** Development of the Tactical Atomic System PLUTON; continuation of the production of the AMX 30 medium tank; continuation of production of the vehicles derived from the AMX 13 light tank (self propelled gun, 155mm, personnel carrier, and engineering combat vehicle); development of the light armored vehicle AMX 10; construction of general service vehicles, engineering equipment, artillery and light weapons, ammunition, and atomic detection and protection equipment; construction of the tactical helicopter SA 330 PUMA (now delivered) and the development of the SA 341 GAZELLE helicopters (both in cooperation with Great Britain).

c. Air Force. Continuation of the construction of the MIRAGE III (versions E and B.E. and of the transport aircraft TRANSALL; development of the Mirage F-1; development, in cooperation with Great Britain, of the tactical support and training aircraft JAGUAR; perfection, also in cooperation with Great Britain, of the missile MARTEL; the Technical Directorate of Air Constructions (DTCA) is the technical service in charge of the development of commercial aircraft: CONCORDE, MERCURE, and AIRBUS.

d. Navy. Completion of the guided missile frigate Duquesne and of various other vessels; continuation of the program of corvettes, and other vessels; continuation of the program of conventional submarines; continuation of the construction of the antisubmarine warfare (ASW) aircraft ATLANTIC (orders from the Netherlands and Italy); completion of the orders concerning the ASW helicopter SUPER-FRELON; development, in cooperation with Great Britain, of the helicopter WG.12; miscellaneous reconstruction (5 escort-vessels), modernization (ASW detection equipment), and reconversion (NARVAL-type submarines).

e. New Research and Development Programs. Antitank missiles (ACRA, HOT, MILAN) and antiaircraft missiles for the army (ROLAND); variable-wing aircraft, new jet engines (M.53) and airborne equipment (VHF-UHF) for the air force; electronics (computers and components, lasers, etc.); new powders and explosives of high power; high performance ammunition.

f. Support Activity. Supporting research and testing by the Directorate of Research and Testing Facilities (DRME).

I. Other Characteristics of French Developmental Strategy

Additional characteristics of French developmental strategy reflect the desire for self sufficiency, resource constraints, and the limited domestic military goods market as well as the unique characteristics of the French political and industrial system. These characteristics, briefly listed here but amplified in subsequent sections, are as follow:

- A cost minimizing (and risk-minimizing) design philosophy based on simple designs, incremental development, and the establishment of requirements within the state-of-the-art.

- The promotion of export sales to expand the military equipment market.

- International collaboration (most notably with the United Kingdom and West Germany) to conserve scarce resources.

- A government-directed consolidation of the defense industry to reduce duplication of resources.

- The firm government control of all elements (in-house, nationalized, and private industry) participating in weapons acquisition, featuring minimization of competition, assignment of areas of specialization, and nationalization of industry as necessary.

- The consolidation of the weapon acquisition function of the separate services into one defense ministry, DMA.

5. Differing Situation Between the United States and European Countries

Personnel of the Logistics Management Institute visited four European countries (France, Great Britain, Sweden, and West Germany) in the course of studying the DOD-contractor relationship.[3] Personnel in these countries continually stressed that differences between their situation and that of the United States explain why Europe has proceeded in the direction it has but which might not be suitable for the United States. They stressed three factors:

a. The lesser size and resource base of their countries has forced trade offs which may not be optimal in other situations.

b. Lacking major world power status, they do not have to be first in everything and ready with a counter to any and all advances by an unfriendly power. Time is a less demanding criterion. They recognize that the responsibilities of a major world power create a much less tractable weapon acquisition problem.

c. The political system of each country provides strong foundations for the administrative processes of planning and executing the defense acquisition program. Major conflicts between the executive and legislative authorities are unlikely. Plans and policies developed by the executive agencies are tantamount to national plans and policies. The executive agencies have a great deal of discretion in management of the acquisition process. Such administrative discretion also channels the development of relationships with industry into less adversary, less formal roles approaching those of a partnership.

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Section III.

STRENGTHS/DIFFERENCES OF THE FRENCH WEAPON ACQUISITION PROCESS DESCRIBED IN PRIOR STUDIES

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1. Prior Studies of Dassault Practices

a. Previous studies – most notably the Rand studies of Anthony and Perry[4-7] – have addressed the relative strength of the French weapon acquisition process vis-a-vis the United States and the Soviet Union. The scope of these studies was limited to the French military aircraft area and, more specifically, to the firm of Dassault (Avions Marcel Dassault-Breguet) which dominates the military aircraft area in France. The question as to whether the Dassault findings can be generalized to other French weapon systems areas (e.g., ground forces weapon systems) is addressed in a subsequent paragraph.

b. Dassault aircraft have established an enviable reputation in the past several decades based on the high quality of their combat performance, low cost of development/production, rapidity of development, and adaptability to a wide range of applications. By 1970, 14 nations had selected Dassault Mirages in preference to other available combat aircraft.

c. The Rand studies[4-7] attribute this outstanding performance to the following design and/or management practices:

(1) Incremental developmental philosophy based on evolutionary improvements of a family of aircraft incorporating only one or two major design changes at a time.

(2) Simple designs aimed at the best obtainable composite of capability and low cost.

(3) Prototype development strategy and austere, rapid design-prototype construction phase aimed at eliminating areas of technical uncertainty prior to commitment of significant resources.

(4) Small design teams with stable employment. A core of 20 to 25 engineers may expand to a maximum of about 100 at the peak of a project.

5. Extensive flight testing prior to production decision.

6. Concentration on design and development rather than production. The bulk of production effort is subcontracted.

7. Dassault participation in the generation of realistic, briefly stated, performance oriented requirements.

8. Cost reduction emphasis as a means of maintaining competitive advantage in international sales and in meeting budget constrained air force needs.

2. Observations of Knowledgeable Source

A knowledgeable source,[8] who is familiar with both US and European weapon acquisition, has made the following observations:

a. Small design teams are found in the French companies of Thompson CSF and Dassault; however, there is generally little difference between design teams in Europe and the United States.

b. In Europe, more emphasis is placed on improving components and subsystems. Stated requirements are based on existing technology for the separate parts.

c. Europeans trade off cost, schedule, and performance in their weapon programs; however, the emphasis is on cost.

d. Europeans rely more on simple systems and incremental performance improvements. They are less likely to build a completely new system from scratch.

e. Generally, European countries do not utilize competing prototype designs because they do not think they can afford it. In particular, France controls industry so that there is actually no competition.

f. There is a definite separation between the R&D phase and the production phase of European weapon acquisition programs. Only when assessments have been made of a completed phase does the next phase begin.

g. Given the same approach and procurement phase, there is no significant difference in the cost of R&D for European and comparable US weapon systems.

3. Extent to which Favorable Dassault Practices Are Detected in Other Areas

a. The overall life cycle model for the French weapon acquisition process is summarized in section V and presented in detail in the appendix. The model appears to incorporate many of the Dassault practices aimed at risk and cost minimization.

b. French armor design philosophy has stressed commonality of components in the families of systems based on the AMX-13 light tank and the AMX-30 main battle tank. The AMX-13 became the basic vehicle for an armored personnel carrier, carriers for mortars and other weapons, 105-mm and 155-mm SP howitzers, a twin SP 30-mm AA weapon system, an ambulance, a cargo transport, and for tank-recovery, bridge-launching, maintenance, and command vehicles. The AMX-30 family will also include some of the above applications and will provide the chassis for the PLUTON tactical missile launch vehicle.

c. From the limited information available, it appears the favorable design/management practices which have been reported for the Dassault/military aircraft area are found to some extent in other sectors of the French acquisition process, but probably not to the extent to which they have been developed in the unique Dassault organization.

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Section IV.

THE ORGANIZATION AND ACTIVITIES OF DMA

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1. Formation of DMA

a. Prior to 1961 the French Minister of Defense had Secretaries of State for Army, Navy, and Air Force, and a technical directorate for each Service. The government felt this was an outmoded concept and wasteful of manpower and money.

b. By a decree of April 1961, DMA was established. The organization was completed with the issuance of a decree in August 1965. Simply stated, the reorganization moved the technical, R&D, procurement and major repair capabilities from the Services into one consolidated Ministry of Defense (MOD) organization. The offices of the Secretaries of the Army, Navy, and Air Force were eliminated and the Services were also reorganized. At that time, in addition to removing the R&D, technical, procurement, and like *functions* from the Services to DMA, the technical *personnel* were also transferred from the Services to DMA. These personnel are the Ingenieurs de l'Armement which are discussed in section VI. DMA works directly for the Minister of Defense. Mr. Blancard headed DMA until March 1974 when he was replaced by Mr. Jean-Laurens Delpech.

2. Responsibilities of DMA

The responsibilities of DMA are to assist the Minister of Defense by: the preparation of armament studies, research, and production programs and the management of these programs in close cooperation with the Chief of Staff of the Armed Forces and the Chiefs of Staff of the three Services; the supervision of public establishments and national companies (Aerospatiale, for example) which are involved in military studies, research, and production; and the supervision of industrial repairs to military equipment.

3. Mission of DMA

a. Determine the military equipment requirements for the three Services in close liaison with the Services and the Chief of Staff of the Armed Forces. As such, the DMA acts as an essentially military organization.

b. Supply to the Services needed weapon systems and equipment by: acting as a procurement agency; acting as an essential intermediary between the manufacturers and the Services; and operating research, study, and production facilities. As such, DMA acts as a true manufacturer from design to equipment construction.

c. Regulate national industrial development by: assisting long-term development of the industrial potential of private or national companies; developing an industrial policy; acting (in behalf of military equipment) as a public agency similar to the Ministry of Industries.

4. DMA Organization

The organization chart (fig 1) shows the structure of DMA. Comments on this organization follow.

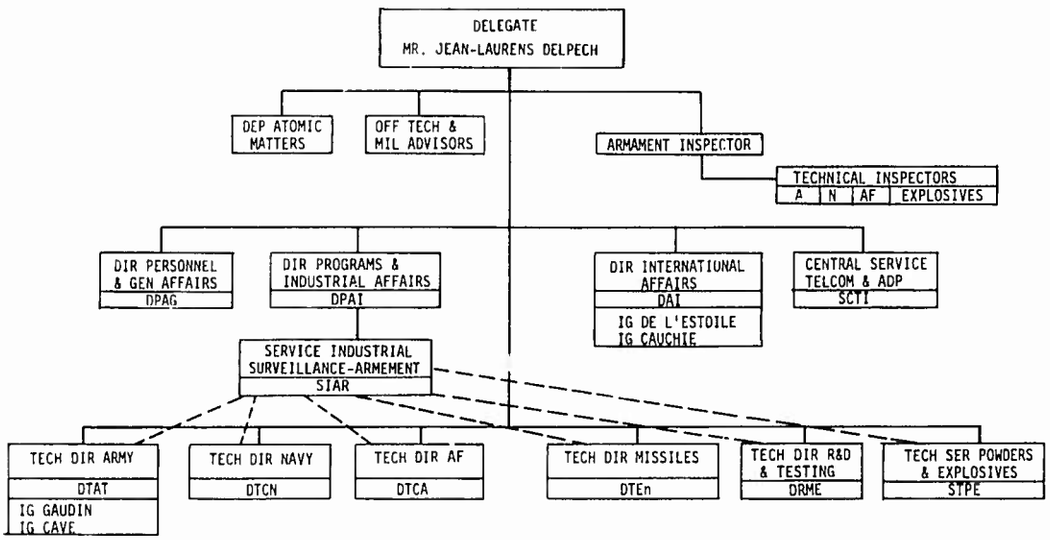

Figure 1. Delegation Ministerielle Pour L'Armement (DMA).

a. Cabinet Technical and Military Advisors. Private staff of Armament Engineers and military advisors who are technical advisors and who coordinate matters between DMA and the services.

b. **Armament Inspector.** Has permanent advisors for technical matters and for formulation of proposals concerning the organization, operation, and functions of armament studies and production agencies.

c. **Directorate of International Affairs (DAI).** Handles all problems of export and sales of armament equipment. Responsible for all questions pertaining to international technical cooperation. Basic responsibility for approving/disapproving procurement of foreign equipment. Has a direct hand in approving French-foreign industrial licensing agreements. Currently headed by l'Ingenieur General de l'Armement de l'Estoile.

d. **Service of Industrial Surveillance for Armament (SIAR).** Has technical control of most weapons manufactured in national defense factories. Administratively supervises contracts including payments and liquidation. Provides the MOD with industrial information.

e. **Directorate for Programs and Industrial Affairs (DPAI).** Prepares and coordinates annual financial plans and budgets. Oversees industrial activities (and problems) of state, semi-public, and private companies. This directorate works very closely with DAI and the technical directorates.

f. **Directorate of Personnel and General Affairs (DPAG) and Central Service Telecommunications and Automatic Data Processing (SCTI).** Basically support functions for DMA.

g. **Technical Directorate for Ground Armaments (DTAT).**

(1) Responsible for the development of requirements, R&D, test and evaluation, procurement, major overhaul, and manufacture of all ground force materiel.

(2) Supervises and operates seven technical and evaluation centers covering biological, chemical, and engineering equipment, weapons and ammunition, and communications and electronic programs, as well as fields of threat evaluation, nuclear detection, etc. For example:

- Bouchet Biological and Chemical Studies Center (SEBC)
- Telecommunications Research and Study Center (SEFT)

- Bourges Artillery Test Center (ETBS)
- Toulouse Airborne Test Center (CAP)

(3) Supervises and operates 11 industrial-type facilities, which mainly study and manufacture armament materiel and weapon systems. For example:

- Mans Factory (ALM): Small calibre ammunition production.
- Roanne Factory (ARE): Production of armored cars.
- Tulle National Weapons Plant (MAT): Production of 20mm and 30mm cannons.
- Issy-les-Moulineaux Factory (AMX): Production of AMX tanks.

(4) The importance of DTAT is indicated by its employment of some 22,000 people.

h. Technical Directorate of Construction, Naval (DTCN). Responsible, like DTAT, for all naval materiel for construction, repairs, R&D, etc. Facilities at Cherbourg, Brest, Lorient, Toulon, Dakar, Papeete, etc.

i. Technical Directorate for Air Weapons and Equipment (DTCA).

(1) Responsible for research, technical tests, production, and repair of aeronautical equipment.

(2) Has both military and civilian competency. Since the French Government (GOF) is the biggest customer of the aerospace industry, the DTCA Ingenieurs actually support this industry.

(3) Operates three test centers: Bretigny sur Orge Flight Test Center (CEV); Propulsion Test Center (CEPR) at Saclay; Aviation Test Center (CEAT) at Toulouse. (In addition to tests of military aircraft, CEAT also tests civilian aircraft such as the CARAVELLE and CONCORDE another example of the military/industry mix.)

j. Technical Directorate for Missiles (DTEn).

(1) One of the newest directorates- established in August 1965.

(2) Responsible for research, construction, testing and deployment (to the services) of ballistic missiles and for space systems, e.g., surface-to-surface ballistic (nuclear) strategic missile (SSBS); sea-to-surface ballistic (nuclear) strategic missile (POLARIS-type) (MSBS); medium range ballistic missile for the army (nuclear) (PLUTON).

(3) Operates two research centers: Ballistic and Aerodynamic Research Lab (LRBA) at Vernon; Propellant and Missile Assembly and Test Center (CAEPE) at St. Medard en Jalles.

k. Directorate for Research, Development, and Testing (DRME).

(1) Preparation of overall scientific and technical research programs for the services and supervision of the resultant work, e.g., the awarding of research contracts to private and public agencies; overseeing State research agencies such as the Office of Aerospace Studies and Research (ONERA) and the French-German Institute at St. Louis; creating, organizing, and coordinating test facilities for DMA and the Services [Landes Test Center (CEL), which is mainly army, and the Mediterranean Test Center, for ballistic missile testing]; providing scientific and technical information for DMA and the Services through the Armament Documentation Center (CEDOCAR); operational research at the Joint Center of Operational Research (CIRO).

(2) The title of DRME is somewhat misleading in that it is not the only RD&T activity in DMA. As was shown, DTCA (Air) is also responsible for R&D and testing. DTAT (Ground) also has RD&T facilities, as does DTCN (Sea).

l. Technical Service for Powder and Explosives (STPE). Provides all powders, explosives, chemicals and rocket motors for the Services. It has eight industrial (State-owned) establishments and three study and research centers. Approximately 50% of the output is sold to the private sector in France and to export customers (again illustrating the close intermix of government and industry).

5. DMA Control of the French Armament Industry

a. The main source of power and action in DMA is DPAI and DAI. These two directorates, led principally by DAI (l'Ingenieur General de l'Estoile), have, over the past 5

to 6 years, restructured the entire French armament industry. Through these directorates, the GOF controls this industry whether the companies involved are private, semi-public, or State-owned. In fact, it is almost impossible to distinguish the line between the State-owned (Aerospatiale, for example) and private (Dassault, for example) companies. In many of the private or semi-public companies, the GOF owns a major interest and even has active duty military and/or engineer officers assigned for duty with the company.

b. The GOF has, in effect, forced the merger/consolidation of many companies with the express purpose of "reducing the great dissipation in the aeronautical equipment sector of industry to enable it to more easily meet the severe international competition, increase opportunities of safeguarding its activities and obtaining new outlets and new markets." (Quote from DMA Bulletin #7, 15 February 1973.) Examples include: 1967 Dassault took over as major stockholder of Breguet; January 1970 Aerospatiale, a State-owned company, was formed by a merger of Sud Aviation, Nord-Aviation and SEREB (Sud-Aviation had previously been formed by a merger of Ouest-Aviation, Sud-Est Aviation, SFERMA, and Heli-Service); February 1973 four companies involved in navigation and autopilot equipment manufacture (CROUZET, SAGEM, SFENA, and SFIM, with a total of about 15,000 employees) signed a memorandum of understanding to combine their efforts in both military and civilian aircraft work in the presence of Mr. Michel Debre, the Secretary of State for Defense. Although not exclusively a military matter, the development of a computer industry has followed a similar pattern. The Delegation a l'Informatique (DI , which is headed by an ingenieur de l'armement and is part of the Ministry of Scientific and Industrial Development, developed in 1967 the "Plan Calcul," and a company—the Compagnie Internationale pour l'Informatique (CII) was formed. Government policy as spelled out by DI in the "Plan Calcul" specifies that CII must get at least 50% of all orders for computers for civilian government requirements and 100% of orders to meet military requirements (if CII can meet specifications).

c. In summary, DMA, principally through DAI, has carefully orchestrated the entire French armaments industry as a tool of the State. Its effort to promote foreign military sales and to fulfill the basically small French Service requirements has resulted in the development of a first class and highly competitive armament industry.

6. Size of DMA and Defense Industrial Effort

a. DMA, so far as its size is concerned, has been described as the number one company in France. It employs some 80,000 persons in approximately 50 establishments. In 1969, the DMA personnel included 1300 Armament Engineers, 1600 Armament Study and Techniques Engineers, 980 detached and administrative officers (including scientists

performing their military service), 1600 high-ranking civilian engineers, and approximately 75,000 technicians, specialists, unskilled laborers and employees.

b. In addition, DMA uses numerous nationalized or private concerns which (with the DMA personnel) total approximately 270,000 persons with an annual business of approximately 16 billion francs. Fifty percent of armament orders are placed with private concerns, 30% with nationalized companies, and 20% with State establishments.

7. Differing Activities of DMA

a. Mr. Blancard, former DMA, stated that it should be emphasized that the activities of the DMA are on two different levels: the public authority level, which is responsible for determining the technical needs, the control and signature of contracts, the evaluation of the solutions proposed, the management of the resources, etc.; and the manufacturing level, whether the DMA manufactures armament in its own service facilities concurrently with, or separately from, private industry.

b. These two aspects were singled out, not just for reasons of clarity, but also to diminish confusion between decision authority and contracting or manufacturing parties which results from the two identities of the State. One identity decides that something is to be done; the other identity actually does the task as a contract executor. In such a case, these two missions are of differing nature. The purpose of the DMA is to strive to increase progressively the separation between the two identities in management, in organizational structure, and finally in the means themselves.[10]

8. Role of Ingenieurs de l'Armement (Armament Engineers)

The French Corps of Ingenieurs de l'Armement (Armament Engineers) provides the core of the executives of the DMA and the managers for the various research, test, construction, procurement, and maintenance activities operated for the services by DMA. As such, they play a key role in the French weapon acquisition process. The unique characteristics of the Ingenieurs de l'Armement are as follows: a carefully designed selection/education process; a continuity of technical assignments (i.e., no rotational assignments to non-technical service duties); unique ranks/titles equivalent to military grades; and career progression within the corps based on progressively higher technical management assignments. This management concept for the provision of career military-technical managers is employed only by France and Spain and is described in more detail in section VI.

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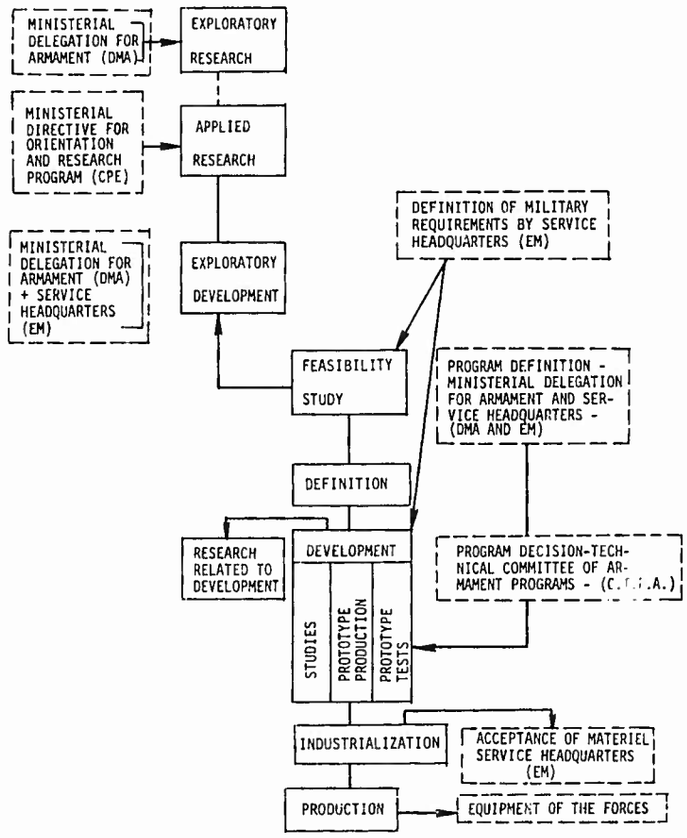
Section V.

THE FRENCH WEAPON LIFE CYCLE MODEL

1. Overview

a. In figure 2, a "flow chart" is presented which depicts, broadly, the steps followed by DMA and the services in developing new weapon systems. The responsibility for execution or coordination of the various steps is also shown.



C.P.E. = CENTER FOR RESEARCH AND DEVELOPMENT PROSPECTS AND EVOLUTION
C.T.P.A. = TECHNICAL COMMITTEE FOR ARMAMENT PROGRAMS
DMA = MINISTERIAL DELEGATION FOR ARMAMENT
EM = SERVICE HEADQUARTERS OR CHIEF OF STAFF

Figure 2. Program genesis and development.

b. The appendix presents a more detailed breakout of the life cycle model provided by MAAG, France.[9] The appendix flow charts have the following sequence of presentation:

(1) Unfolding of Army Armament Programs (Overview).

(2) Preliminary Phase: Military Requirement Definition.

(3) 1st Phase: Program Definition - Study Management.

(4) 2nd Phase: Realization, Tests, and Experimentation of Prototypes.

(5) 3rd Phase: Production Engineering for Manufacturing.

(6) 4th Phase: Preproduction Realization and Tactical Testing.

(7) 5th Phase: Production-Acceptance-Accountability of the Service Directorate.

(8) Placement of New Materiel Into Service in Troop Units.

c. The appendix flow charts are self-explanatory and depict a carefully developed sequence of steps designed to generate pragmatic requirements and reduce uncertainty before entering each succeeding step.

2. DMA Description of the Life Cycle

Mr. Blancard,[10] has described the conception, development, and production of French weapon systems as follows:

> "The statement of military requirements is the responsibility of the service staffs. Acting with them in close, continuous and confident cooperation, the Ministerial Delegation for Armament is, at this level, a technical advisor, responsible in particular, for the translation of operational needs into technical specifications and for demonstrating the feasibility of the requests and the impact of the desired performance on cost and delivery dates. Then, the Ministerial Delegation for Armament is responsible for the supervision of the program selected, controlling at the same time the quality of the armament as well as the cost and the delivery dates. . . .

"Before launching a program, it is essential to identify exactly what it contains and to estimate with the maximum of realism the expenses involved and the time required. This is the purpose of the preliminary study.

"A new program is born from the meeting of an idea of realization which may originate from a staff, a directorate of the DMA, or an industrial firm, with an operational need, existing or expected, and not always clearly determined. Then, a discussion begins between the General Staff and the Delegation in order to determine by successive approximations the military characteristics of the equipment or system to be developed and their translation into technical characteristics. The firms liable to develop and manufacture this equipment or system and the economists responsible for inserting this new program in the financial context must be closely associated in this discussion.

"At this phase, it is essential to research systematically every possible solution corresponding to the more or less ambitious characteristics of the program. The staff must know the cost of every technical requirement; it will then advisedly select the best compromise between cost and performance.

"Preliminary studies will determine the feasibility, through computer studies or actual test, in order to find out if the project is feasible.

"Studies comparing cost and efficiency are more and more frequent in order to determine the most advantageous solutions. In the past, the technicians used to offer the most sophisticated solutions without considering the expenses; today, the cost is one of the main factors. An equipment meeting only the need which has been previously accurately determined by adequate operational research, and which can be financed, is more reliable than an equipment more sophisticated—but beyond the need—and which, because of its high cost, will remain only a project or will be abandoned after the prototype is built.

"Another important consideration: the cost of the equipment determines at the same time the volume of the series and the production schedule, and varies proportionally inversely to one and the other. There is obviously interest to find, for our equipment, a market outside of our own Armed Forces, therefore, the necessity of considering the export aspect (an important factor although not decisive) in the discussion between officers and engineers on the definition of the program.

"This preliminary study is finalized by the establishment of a document determining the program, the conditions of its development and the organization required for its realization.

"After the decision to launch the program is taken, one enters the development and production phase which comprises generally the following steps: (especially for equipment manufactured in large quantities)

- Development of one or several prototypes: first, prototypes to verify the possibility of a technical solution, then prototypes for the study of an operational solution, for the technical tests and military experimentation;

- Construction of the production equipment (tooling, testing and control equipment);

- Construction and expermentation of a preproduction series, then, mass production (including maintenance spares, documentation, . . .)

"The duration of the process of definition, development and production of modern armament equipment (from the portable weapon to the fighter-aircraft or missile) is very often of approximately 10 years. For this reason, many precautions are required before starting this process. Preliminary research (in connection with Directorate for Research, Development and Testing (DRME) studies) is conducted. For this reason also, an important part is allocated to the planning of the technical research and to what the Third Law of Program calls 'Preparation of the Future' and which comprises:

- Research leading to new combat processes, including eventually the construction of mock ups or test models to verify the value of the new technical solutions;

- Studies and Realizations of general interest;

- Weapons system test centers."

3. General Comments on Life Cycle

a. The services participate in the system early in the requirement and definition phases but the basic R&D and testing is carried out within the DMA. The services become

involved in the testing cycle, normally, only at the operational testing and evaluation phase, after prototype testing is completed.

b. The weapon systems developer/producer participates in requirements definition whether the producer is an in-house facility or an industrial firm, such as Dassault.

c. The requirements statements which are generated are minimal requirements with great emphasis on cost, export market competitiveness, and production quantities.

d. Extensive use is made of prototype testing.

e. The system is supported by a research and operations research program designed to provide the required technology base and analytical capabilities for the design and selection of weapon systems.

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Section VI.

R&D PERSONNEL

A. INGENIEURS DE L'ARMEMENT

1. Background

A key to understanding the workings of the French military/industrial complex are the French Corps of Ingenieurs de l'Armement (Armament Engineers). Prior to a law of 21 December 1967, there were a number of military engineer corps (armament, naval construction, aeronautics, powder and explosives, telecommunications, work engineers, etc.). Effective 19 March 1968, all of these corps were merged into two Armaments Corps, the Armament Engineers and the Armament Technique and Research Engineers.

2. Education/Selection

a. Approximately 80% of the Armament Engineers are graduates of the Ecole Polytechnique. This school is roughly similar to a combination of MIT and Cal Tech, but is operated by the French military as a military school. Competition for entrance is keen. Students enter after receiving the baccalaureate degree (which approximates completion of two-year junior college in the United States).

b. The balance are recruited from graduates of other technical or professional universities.

c. Upon selection, young armament engineers formerly entered one of seven "service or branch" national postgraduate courses as follow: aeronautics, armament (army), naval construction, powder (explosives, propellants, missiles), telecommunications, electricity, and nuclear weapons.

d. With the consolidation of the many corps into two corps the postgraduate courses were consolidated into two: the National School of Aeronautics (ENSA) at Toulouse, and the National School of Advanced Techniques (ENSTA) in Paris.

e. After completion (or prior to attendance) of the postgraduate courses the Armament Engineers attend a service academy for 1 year of general military studies.

f. There are approximately 1300 Armament Engineers. Almost all of the approximately 1500 Armament Technique and Research Engineers are graduates of less prestigious schools and do not enjoy the same status as the Armament Engineers. Where two engineers of the same rank are stationed together, the Ecole Polytechnique graduate will command.

3. Ranks/Titles

a. The Armament Engineers have ranks equivalent to the military. Although they are seldom seen in uniform, they do wear them for certain occasions.

b. Upon completion of their total schooling they are "commissioned" at the equivalent rank of USA captain.

c. Title, abbreviation of title or "rank," and equivalent USA rank are:

Ingenieur de l'Armement (IA)	Captain
Ingenieur Principal de l'Armement (IPA)	Major
Ingenieur en Chef 2d Class (ICA)	LTC
Ingenieur en Chef 1st Class (ICA)	Colonel
Ingenieur General de l'Armement (2nd Class) (IGA)	Brig. General**
Ingenieur General de l'Armement (1st Class) (IGA)	Major General***

** Two star insignia
*** Three star insignia

d. The Engineers of the Armament Technique and Research Corps are titled: Ingenieur des Etudes et Techniques de l'Armement (IETA); Ingenieur Principal des Etudes et Techniques de l'Armement (IPETA); Ingenieur en Chef. . . and so on.

4. Functions/Duties

a. Although the various corps have been consolidated, individuals tend to continue to be functionally oriented with army, navy, or air force specialization.

b. The Engineers provide the executives for the various research, test, construction, procurement, and maintenance activities for the services. The Engineers manage these (and other) facilities under the overall supervision/control of DMA in a manner roughly equivalent to the US DOD but with much more power and authority.

c. The Engineers also provide the core of the executives of the DMA.

d. Career progression is based on a series of technical management or scientific assignments of progressively higher responsibilities. Engineers are not given rotational assignments to regular service duties.

5. A Career in Three Periods

Generally, the career of an engineer comprises three main periods, the beginning of each being the occasion of an orientation.

a. **First Period.** For the engineer, the first orientation varies with the manner of recruitment (graduated from Ecole Polytechnique or recruited through competitive examination), from the choice of a branch (army, air force, navy, special weapons), and the selection of a technical specialty for which he receives training during his stay at the Sup'Aero (Advanced Aeronautics School) or the ENSTA. These factors condition his first assignment. During this period, which extends approximately 10 years following termination of his training, the young engineer is placed at the disposal of a technical directorate (DTCA, DTCN, DTE, or DTAT). During the first 3 years, he is given a training assignment in either an industrial establishment, a test center or a laboratory, where he learns his job while rendering increasingly important services. Generally, during the following years, he remains assigned to the same technical directorate. During this phase, the engineer participates in short periods of improvement training. During this period (or during the following one) certain engineers may participate in long training periods to achieve additional specialization.

b. **Second Period.** The engineer has reached approximately the age of 35 and has the experience of 10 years in his job. He may select among three types of careers: a specialist career skilled in a given technical or scientific field; an essentially technical career, as monitor or coordinator of a joint-technical team, project officer for weapon systems, chief of a group in a technical service, etc.; or a career of administrative or industrial management, e.g., functional assignments in the establishments or staff duties at the central administration, subdirectorate, and directorate levels. It is during this second period, of approximately 10 years' duration, that the aptitudes for the highest assignments in the

Armament Corps are revealed (the real selection being made at the beginning of the third period).

c. Third Period. At the age of approximately 45, the engineers are personally informed of their possibilities of access to the various assignments, and, in particular, to the highest ones. The selected engineers eventually occupy the key management positions in the DMA. Others remain at the levels achieved during the second career period and still others move to positions in the defense industry. At the present time, 845 Armament Engineers are employed by the administration or by private or nationalized companies where they are detached or which they joined after resigning.

B. PROGRAM MANAGERS

6. DMA Program Managers

The DMA makes use of program managers for major systems. Their functions are briefly listed in the appendix life cycle model. Program managers are drawn from the Ingenieurs de l'Armement and are selected primarily for their general management ability. The Logistics Management Institute[3] provided the following information regarding program management in Britain and France. The program manager is not responsible for defending his program or participating in its advocacy within or without the central procurement organization. Other people are responsible for these functions. The program manager is responsible solely for executing a defined program within established performance, schedule, and cost parameters. In Britain and France, it is thought that program managers should not be drawn from user organizations. While user input is essential, program managers need more objectivity regarding the total program e.g., cost impact among other factors than can be expected if they are users also. In France, this objectivity is provided by the Ingenieurs de l'Armement who are outside of user commands.

C. DESIGN TEAMS

7. Comparison of US and French Design Teams

The efficient use of small design teams by Dassault was discussed in section III. Shapiro,[12] based on a study of French (apparently Dassault) and US aerospace practices, found, for similar development programs, that US engineering manhours were 6½ times as great as the French effort. He attributed this to: the maintenance of recognized design teams in Europe; small design team size and continuity (studies suggest 5 years are required for peak creativity) leading to valid communication and teamwork; US practice of showing technical

capability by high density of degrees (i.e., scientists) rather than proven designers; US *project* orientation resulting in suboptimization to the detriment of subsequent projects and continuity of design teams; and US procurement documentation which is much more complex and voluminous than for the French. Shapiro recommended imitating successful French practices by placing a greater value on successful design teams and removing contractual and procedural pressures which lead to the use of large numbers of people on US R&D projects.

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Section VII.

COSTING

1. Introduction

Little information was obtained regarding French weapon costing techniques and results; however, the limited evidence available indicates French cost estimates compare favorably with US cost estimates.

2. Summary of French Costing Results

Kaldor[2] listed increases (relative to initial estimates) in French expenditures for nuclear weapon and conventional weapon systems. The summary results were as follows: For strategic nuclear systems the actual expenditures were 190% and 117% for the periods 1960-1964 and 1965-1970, respectively; for conventional weapons, actual expenditures were 113% and 90% for the same periods. Differing system categories and time frames were used for US cost estimating results; however, the results generally indicate greater costing accuracy for the French systems.

3. Dassault Costing Practices

Perry[6] reports Dassault uses both "built-up" and parametric cost estimating techniques relying heavily on experience drawn from 25 years of experience during which the company built 24 military aircraft prototypes. Dassault claims its cost estimating accuracy is normally no more than 10% in error. Perry notes that normal error for recent US programs is 40 to 80 percent. Perry attributes the Dassault accuracy to experience, incremental developmental philosophy, risk aversion, and company emphasis on cost control.

4. Contracting in Small Steps

Several references[3,6] mention the practice of step-by-step contracting as a means of controlling project uncertainty. A program is divided into small steps which limit the contractor's risk and improve the opportunity for fixed price contracting.

5. Types of Contracts

Cost reimbursement contracts are generally used in development programs of high uncertainty; however, there is concern for the lack of cost control in such contracts.[3] There is strong pressure to aim at a fixed price at the earliest possible date. Where cost reimbursement contracts are used, the contract segments are generally short and the contractor is made aware that costs exceeding budgeted amount are likely to lead to program cancellation.

Section VIII.

TECHNOLOGY BASE

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1. Research in DMA Facilities

a. As noted in section IV, the four technical directorates (ground, air, naval, and missile systems) all maintain in-house facilities which operate research programs to sustain the technology base in their mission areas. In addition, DRME operates two "corporate laboratories," the Institute of Saint Louis (Institute Franco-Allemand de Recherches de Saint Louis-Mulhouse, France), and the Office of Aerospace Studies and Research (Office Nationale d'Etudes et de Recherches Aerospatiales - ONERA).

b. The Institute of Saint Louis is a French-German laboratory having a staff of approximately 600 people with both French and German directors. The institute was created after World War II as a means of utilizing captured German scientists. The laboratory functions include ballistics, aerodynamics, physics, and metrology.

c. ONERA has acquired an excellent reputation for the research it performs in the areas of aerodynamics, structures, physics, and materials.

d. The place of DMA-supported research in the weapon acquisition process is depicted in general terms in the early phases of the life cycle model shown in the appendix.

e. Data Exchange Agreements (DEA) provide exchanges between the United States, France, and other participating countries of technical and scientific information of mutual interest. These are useful in avoiding unnecessary duplication and in promoting closer cooperation at the working level for all countries.

f. The DMA in-house facilities also support a considerable amount of contractural research with private firms as well as fundamental research at universities. Figures were not available regarding the ratio of in-house to external research.

g. France (as well as every other nation including the Soviet Union) draws to the fullest extent on the research and technology generated by the United States.

2. The National Effort for Research

a. The national effort for research amounted to 12.65 billion francs in 1969, of which 8.9 billion was financed by the State (including 2.4 billion for the armed forces) and 3.75 billion by the private sector. The part developed by the State is about 40% (5 billion), and the part of the nationalized or private industry is the remainder, 7.65 billion.[10]

b. To encourage industry's active participation in research, government provides generous incentives in the form of tax exemptions connected with R&D expenditures, e.g., fifty percent writeoff in the first year of capital expenditures on buildings and equipment purchased for research purposes.

c. French science policy structure is highly centralized and closely organized. The Prime Minister has direct authority over planning and coordinating the overall research program. In June 1969, the Ministry of Scientific Research and Space and Atomic Development was merged with the Ministry of Industry to form the Ministry for Industrial and Scientific Development. This ministry controls a considerable portion of the governmental science budget and has a predominant voice in approximately 50% of governmental spending for R&D.

d. The Atomic Energy Commission (CEA) maintains research centers at Saclay, Grenoble, Cadarache, and Fontenay-aux-Roses as well as six military centers subordinate to its Division of Military Applications.

e. Chief advisor to the Prime Minister for research in the area of national defense is the Scientific Action Committee of National Defense (CASDN), which is charged with the initiation and coordination of defense research. CASDN occupies a position in national defense similar to that of the Interministerial Committee for Scientific and Technical Research which reviews the overall non-defense research program and offers advice to the Prime Minister on research structures, programs, and budgets.

f. The system for the organization and financing of research in France (as well as West Germany and the United Kingdom) is well defined in a 1972 OECD publication.[14]

Section IX.

IN-HOUSE FACILITIES

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1. The Role of State-Owned Defense Establishments

As a matter of policy, West Germany has no defense in-house establishments such as arsenals and laboratories. Sweden does not appear to make use of them. Great Britain relies almost exclusively on private industry to do its engineering work but the defense establishments provide the following main functions: to do defense related research; to assess industry proposals for technological feasibility and cost schedule realism; to monitor or supervise work assigned to industry; to help firms in time of technical crisis; and to test and evaluate the effectiveness of systems during development. France relies quite heavily on State-owned organizations to accomplish defense needs, and State-owned facilities are seen as a countervailing force on industry.[3]

2. DMA In-House Facilities

As noted in section IV, DMA has delegated technical responsibilities for weapon classes to four technical directorates: DTAT (Ground), DTCN (Naval), DTCA (Air Weapons and Equipment), and DTEn (Missiles). In addition, a technical service, STPE, has responsibility for powders, explosives, chemicals, and rocket motors; and DRME has overall responsibility for research and testing. Each of these DMA elements operates State-owned facilities. Summary statements and/or examples of facilities were provided in section IV for the above DMA elements. The remainder of this section will concentrate on the in-house facilities for ground forces weapon systems.

3. Technical Directorate for Ground Armaments (DTAT)

a. DTAT has two differing functions, a State function and an industrial function, as follow:

(1) The State function of DTAT is to meet the technical requirements of the French Armed Forces, i.e., it must: define the technical specifications of the materiels in cooperation with the staffs; manage technically and financially the design and manufacturing contracts concluded with the industrial sector; carry out the technical evaluations; and take part in the industrial policy of DMA.

(2) It essentially deals with ground armaments. The army staff is thus its main customer, but it can supply the other forces.

(3) DTAT also has an industrial function for design and production. It has at its disposal the national manufacturing establishments which form the "Groupement Industriel des Armements Terrestres" (GIAT). DTAT works also with private or nationalized companies, especially in the fields of electronics, missiles, and optics.

b. Certain advantages result from the creation of GIAT to perform the industrial functions.

(1) The State-control mission is reinforced and better ensured. Before the creation of the GIAT, numerous engineers were responsible for functions involving both the industrial aspect and the State control aspect. From this viewpoint, the specialization generated by the formation of the GIAT was favorable.

(2) Improved knowledge of the actual price of production by State industry resulted. Formerly, the expenses of the industrial function had been mixed with those of the State-control function. The separation of these two types of expenses was facilitated by the creation of the GIAT.

(3) Increased coordination and control was achieved of the 11 organizations within the GIAT.

c. The other eight DTAT organizations (excluding its central administration) are: the central contracting service whose function involves making contracts for the production of armaments with private or nationalized industries; six technical or testing centers with the missions of specifying and supervising armament studies, technically evaluating prototypes, acting as technical experts for the central administration, and making contracts for the manufacture of electronic equipment; and a training center.

d. Of the 22,000 DTAT personnel, 17,000 are GIAT employees. The activity of the DTAT, including all the contracts made directly with private industries, involves approximately 3 billion francs; the turnover of the GIAT is approximately 1.5 billion francs.

4. Groupement Industriel des Armements Terrestres (GIAT)

Ingenieur General Massard of GIAT provided the following description[13] of GIAT activities in 1972:

"Two years ago the decision was made to create the GIAT by uniting 11 organizations and creating within the Central Administration a department responsible for insuring their coordination. These 11 organizations are of an industrial nature, signifying that they are responsible for designing, producing, and repairing armament materiel. . . . The GIAT is the industrial branch of the DTAT. It differs from other industries in that it is entirely subject to administrative regulations: all personnel have State status, be they civil servants, contractors, or laborers; salaries and manpower are determined by the State; its purchases are in the form of State contracts made according to contract regulations, after the consent of control organizations when the total amount involved exceeds certain limits; no stocks or shareholders who would control the organization or receive dividends are involved. The GIAT is integrated into the hierarchical structure of the Armed Forces Ministry, and is subject to the control of the Inspector General of the Armed Forces.

"It has no financial or legal independence with respect to the State. The GIAT can make contracts only in the name of the State. It cannot obtain loans from banks or Treasury advances. Its funds come exclusively from the State budget or from payment by foreign or private clients.

"Since the mission of the GIAT almost exclusively involves armaments, its activity is determined to a great extent by the budget of the National Defense, whereas private industries are involved in large-scale non-State-controlled activities enabling them to withstand variations in the volume of State contracts. . . .

"For 20 years the DTAT has had a special Treasury account called the 'Business Account of Armament Productions' similar to that of private companies, enabling the organization to establish an overall operating account, an account of losses and profits, and a statement of affairs every year. The GIAT now has its own accounts which are much more similar to those of a private company. . . . The GIAT is competitive with respect to French and foreign industries.

". . . The GIAT is active in the development of almost all types of ground armaments. The three major areas of activity of the GIAT are armored vehicles, weapons, and ammunitions.

"The AMX combat tanks, APC's, recovery equipment, bridge laying equipment, construction vehicles, 105 or 155 mm artillery materiel, and antiaircraft vehicles are known worldwide. Nearly half of the AMX 13 tanks manufactured have been exported. The AMX 30 has been put under full scale production. The first AMX 10's have just been released.

"The design and development of prototypes and preproduction models or armored vehicles are under the supervision of the Issy-les-Moulineaux Factory (AMX) at Satory near Versailles. The research departments of various organizations and industries are participating in this work.

"Mass production is performed by several GIAT organizations:

- Roanne Factory (A.R.E.), development of the body and final assembly (99% of its activity);
- Tarbes Factory (A.T.S.), manufacture of turrets (40% of its activity);
- Bourges Establishment of Armament Research and Manufacture (E.F.A.B.), production of main armaments (90, 105, 120, or 155 mm guns) (50% of its activity);
- St-Etienne National Weapons Plant (M.A.S.), production of light turrets equipped with machine guns or 20 mm automatic guns (35% of its activity);
- Tulle National Weapons Plant (M.A.T.), production of the weapons mentioned above: machine guns and automatic guns.

"Private or nationalized industries also participate a great deal in the production of engines, armor, radio units, optics, and diverse mechanisms.

"The weapons section has been mentioned only with respect to armored vehicles. To complete this description, the following should be added: 30 mm guns manufactured by the Tulle plant (M.A.T.) for the Air Force or Air and Sea Forces, or for airplane manufacturers who export their products; and individual weapons (rifles, pistols, rocket-launchers) manufactured by the St Etienne plant (M.A.S.), plus diverse subcaliber practice weapons.

"The activities of the ammunitions section are diverse, from the pistol cartridge to the antitank missile.

"The E.F.A.B. supervises research related to weapons and ammunitions, but relies heavily on the manufacturing organizations.

"The Mans Factory (A.L.M.) (100% of its activity) and the Toulouse Factory (50% of its activity) manufacture infantry cartridges. The latter is the manufacturer of 20 and 30 mm ammunitions, in cooperation with the E.F.A.B. (fuzes) and the Salbris Loading Factory (A.S.S.) for the loading of explosive ammunitions. The Tarbes factory makes primers for all the ammunition.

"Artillery ammunition is loaded and assembled by the Salbris factory, with several organizations participating in their manufacture: the shell body and the primers are made at the Tarbes factory (A.T.S.), the shell cases at the Rennes factory (A.R.S.), and the fuzes at the E.F.A.B.

"In the area of antitank rockets, the Puteaux Factory (A.P.X.) employs its research department, and the St-Etienne plant controls production in which the factories of Salbris, Rennes, and Tarbes and the E.F.A.B. participate.

"With respect to missiles, the A.P.X. research department is of prime importance, while several establishments participate somewhat in production: the St-Etienne plant, the Salbris factory, and the E.F.A.B.

"Another area involves materiel for nuclear and chemical protection, detection, and decontamination. To a great extent, the St-Etienne plant is responsible for the manufacture of this materiel, which corresponds to a smaller volume than the preceding materiel.

"The study and production of armament materiel represents more than 95% of the activity of the GIAT (exportation is 1/5 currently, probably close to 1/4 in 1974). . . .

"The turnover at the GIAT in 1972 was approximately 1500 million francs. The main categories are:

- armored vehicles - 47%
- ammunitions - 29%
- weapons not mounted on armored vehicles - 6%
- diverse manufactured articles - 10%
- research and development - 8%.

"The 'added value' of the GIAT represents 35% of its turnover, which illustrates the importance of subcontracting and purchasing in private industry and results from the practice of calling on the industry rather than increasing the capacity of the state organizations. . . .

"The major clients to which the GIAT furnishes studies or materiel are:

- the Ground Forces Staff - 60% of the sales,
- the Central Directorate of Ground Forces Materiel - 10%,
- exportation - 20% rapidly increasing for the past 2 years ,
- miscellaneous - 10%."

Section X.

DEFENSE INDUSTRY

1. Distribution of Armament Orders in France

The tables presented in the following paragraphs are adapted from reference 10.

a. Table IV shows, for 1969, the distribution of armament orders between the three sectors: State industry, nationalized industry, and private industry.

Table IV. Distribution of Armament Orders

(in billion of francs)

	State industry	Nationalized industry	Private industry	Total	Remarks
Naval Construction	975	---	800 (1)	1775	(1) Of which 40% represents electronics
Aerospace and Aeronautic Construction	100	1300 (2)	2700 (2)	4100	(2) Of which 25% represents electronics
Land Armament	500	100	480 (3)	1130	(3) Armor & General Service Vehicles
Ammunition	300	---	150	450	
Electronics	---	---	900	900	
Atomic	100	1000	1250	2350	
Research and Development (Atomic excepted)	1120	600	1080	2800 (4)	(4) Including Prototype construction
Total	3145	3000	7360	13,505	

b. Table V indicates the share of armament orders in the total production of the most important industries. This distribution confirms that the industries closely connected with armament orders—and more sensitive to the variations of the situation in this field—are the aerospace industries, the electronics industry, and, to a lesser degree, the accessories industries. Armaments represent only a very small percentage of the activities of other industries.

Table V. Share of Total Production of Each Industry (1969)

(in billion of francs)

	Amount of armament contracts with private or nationalized industry	Total production of the industry	% of total production (armament orders)	Remarks
Machines & Mechanical Apparatus ----	650	9300	7	
Electronics --------	2200	5100	45	
Automobile ---------	400	33,000	1.2	
Naval Construction ----------	100	2500	4	Technical Directorate of Naval Constructions excluded
Aerospace Construction ---------	3000	6500	46	
Arms & Ammunition ---------	250	600	40	Technical Directorate of Ground Armaments excluded
Chemical Products -	100	2500	4	Fuels excluded
Research & Development --------	1680	7650	22	Including prototype construction

c. 270,000 persons are working on armament orders (exports included), as follow:

- State industry 80,000
- Nationalized industry 33,000
- Private industry 122,000
- Atomic Test Center and allied agencies 35,000

2. Consolidation of the French Armaments Industry

a. As noted in section IV, DMA, over the past 5 or 6 years has restructured the entire French armaments industry. The other three major European countries (United Kingdom, Sweden, and West Germany) also have followed this practice of defense industry "rationalization." Rationalization, a British term, means to eliminate duplication of R&D activities or duplication of production activities. In a broader sense, it means action by the government to structure both government and industry activities to meet present and future defense needs in the most efficient manner under conditions of limited market and resources. The elimination of duplication implies that no worthwhile purpose is served by having more than one source engaged in some specific activity. The cost of developing and maintaining the same capability in two sources is too great under European conditions. [. . . they feel that if two sources exist for a major item, there is one too many. This view is generally accepted in all four countries.[3]

b. As a result of the consolidation or rationalization of the defense industry, competition has been substantially reduced in the defense market place. European defense managers support the proposition that competition is beneficial in development and in production as a means of obtaining improved technology and lower prices. Most managers, however, feel it is rarely possible to maintain conditions for competition among European domestic sources for the development of complex equipment, with the possible exception of electronics equipment. The production base is larger than the development base so that production competition is a less limited possibility. Practically speaking, competition is recognized as desirable but seldom obtainable. As a consequence there is wide acceptance that sole-source development and mostly sole-source or limited-source production will be the normal way of life in the European defense market. Competition pitting domestic sources against foreign suppliers has largely replaced competition among domestic sources.[3] In 1969, over 50% of the French aerospace production was for export[2] and 20% to 25% of other French armaments were produced for export.

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Section XI.

SUMMARY OF MAJOR FINDINGS

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1. Findings

a. The French national policy of self-sufficiency in defense matters, coupled with the relatively limited resources available and a small domestic military market, has resulted in severe cost and market constraints which strongly influence the French weapon acquisition process.

b. The firm of Dassault has gained a reputation for the efficient use of R&D resources. The limited information available indicates that favorable management/design practices are found, although to a lesser degree, in other weapon areas.

c. The French design philosophy stresses evolutionary (as opposed to revolutionary) weapon systems development based on incremental improvements and risk/cost minimization relying on austere but thorough design and prototype testing prior to production decision.

d. The French life cycle model has a well-developed series of steps designed to yield pragmatic requirements and minimize uncertainty through a carefully developed sequence of decision points.

e. French military R&D managers are drawn predominantly from the unique Corps of Ingenieurs de l'Armement (Corps of Armaments Engineers). These engineers have military rank and a career pattern aimed at developing highly capable weapon acquisition specialists.

f. The French weapon procurement system appears to promote the recognition and maintenance of small, stable, and capable design teams.

g. The weapon systems acquisition functions of the services were merged into one centralized organization (DMA) with technical directorates having responsibility for service-related systems (i.e., ground, air, naval, and missile systems).

h. France relies quite heavily upon State-owned organizations (in-house facilities and nationalized companies) to satisfy its defense needs as well as upon private industry. Weapon-related activities of all three types of organizations are carefully orchestrated by DMA.

i. DMA, in the past 5 to 6 years, has directed a major restructuring of the French defense industry to eliminate duplication of weapon activities. This was brought about largely by necessity due to the small and declining market for European weapons and to rising costs. The results are (1) elimination of marginal companies as separate corporations; (2) greater participation by government in the defense industry; and (3) virtual elimination of competition within the domestic defense market. French spokesman agree to the advantages of competition, as practiced in the United States, but also describe competitive practices as a luxury they cannot afford.

j. Exports of French weapon systems have been actively sought as a means of offsetting the small domestic market. Competition pitting domestic sources against foreign suppliers has largely replaced competition among domestic sources.

APPENDIX.

DETAILED LIFE CYCLE MODEL

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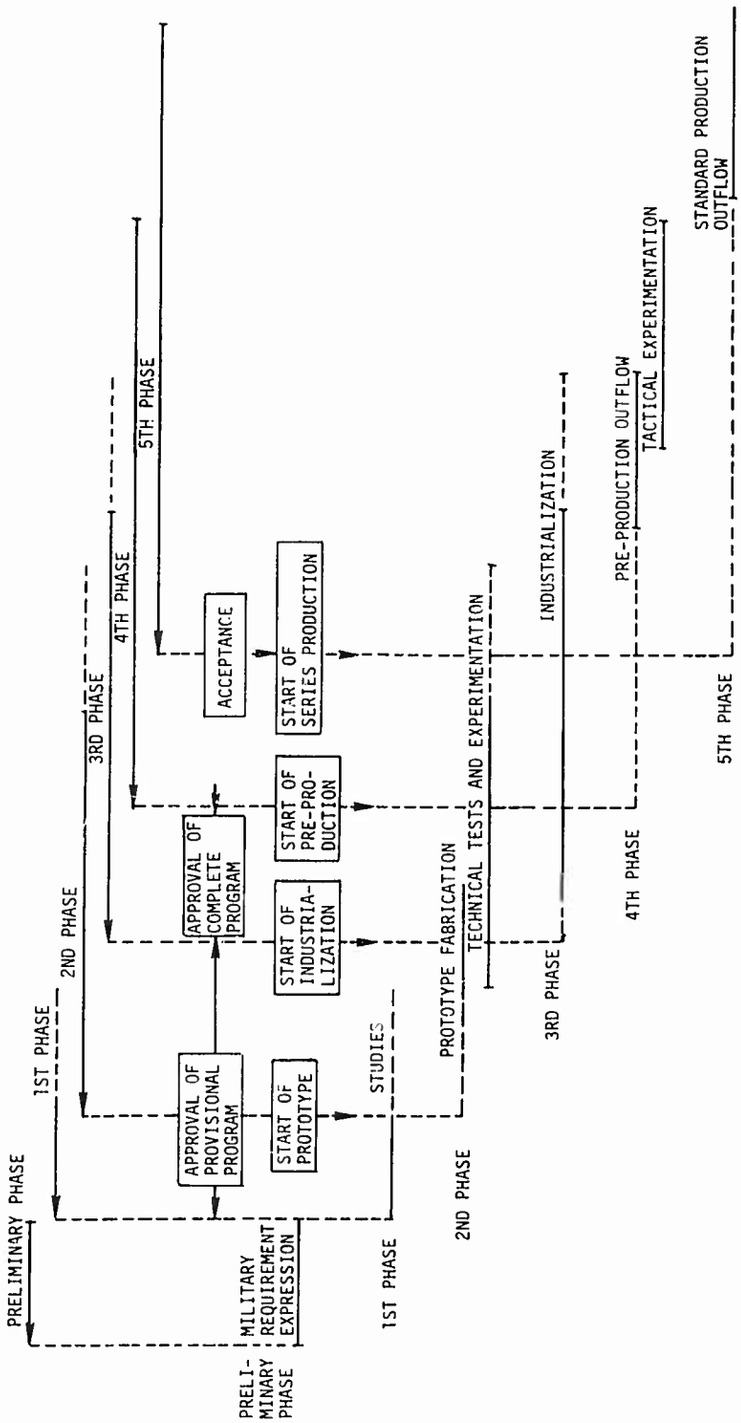
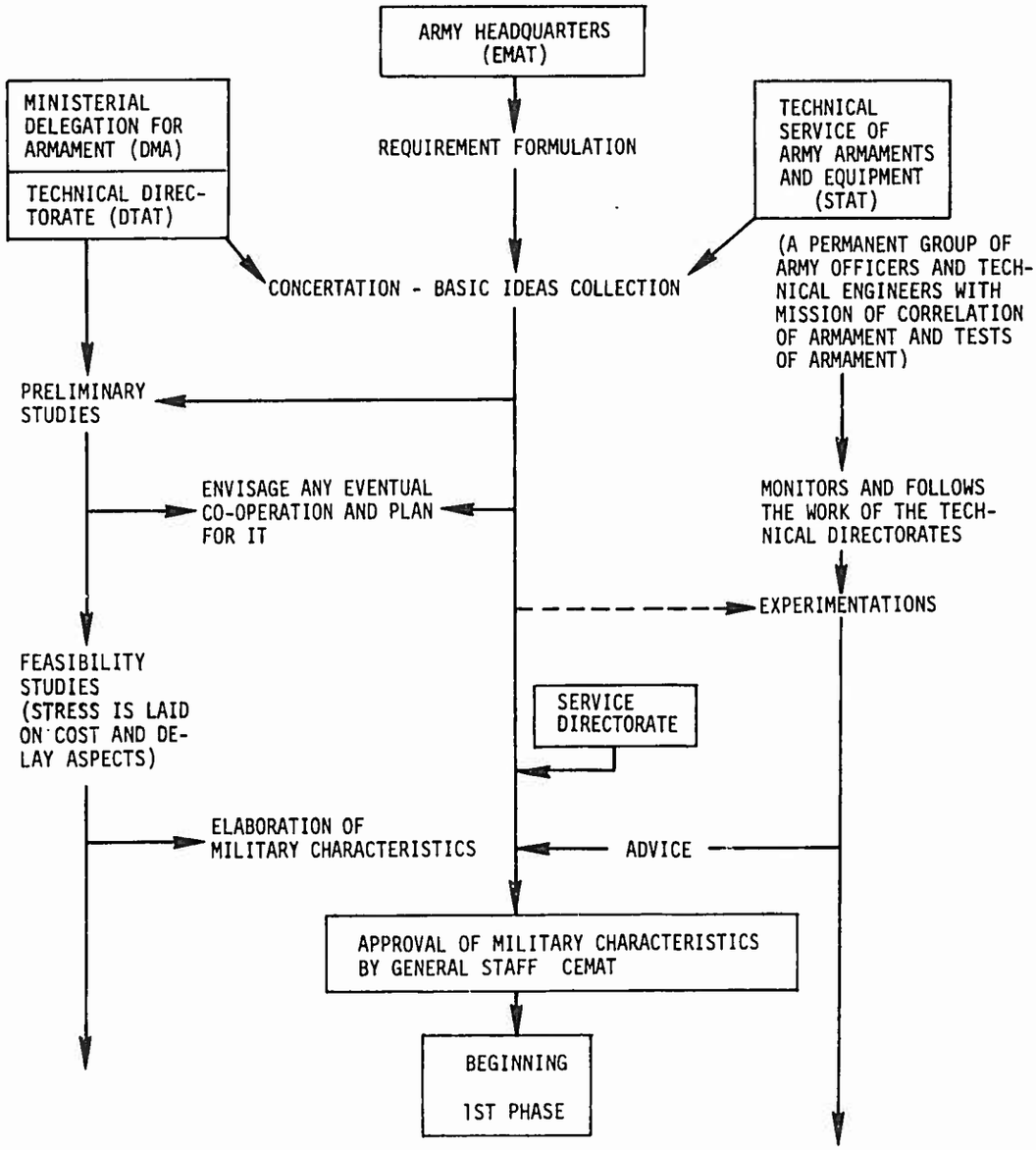


(1) THE START OF PRE-PRODUCTION COULD BE ACCOMPANIED BY AN ACCEPTANCE IN PRINCIPLE AT THE SAME TIME.

Figure 3. Unfolding of French Army armament programs.



(See Figure 5)

Figure 4. Preliminary Phase: Military requirement definition.

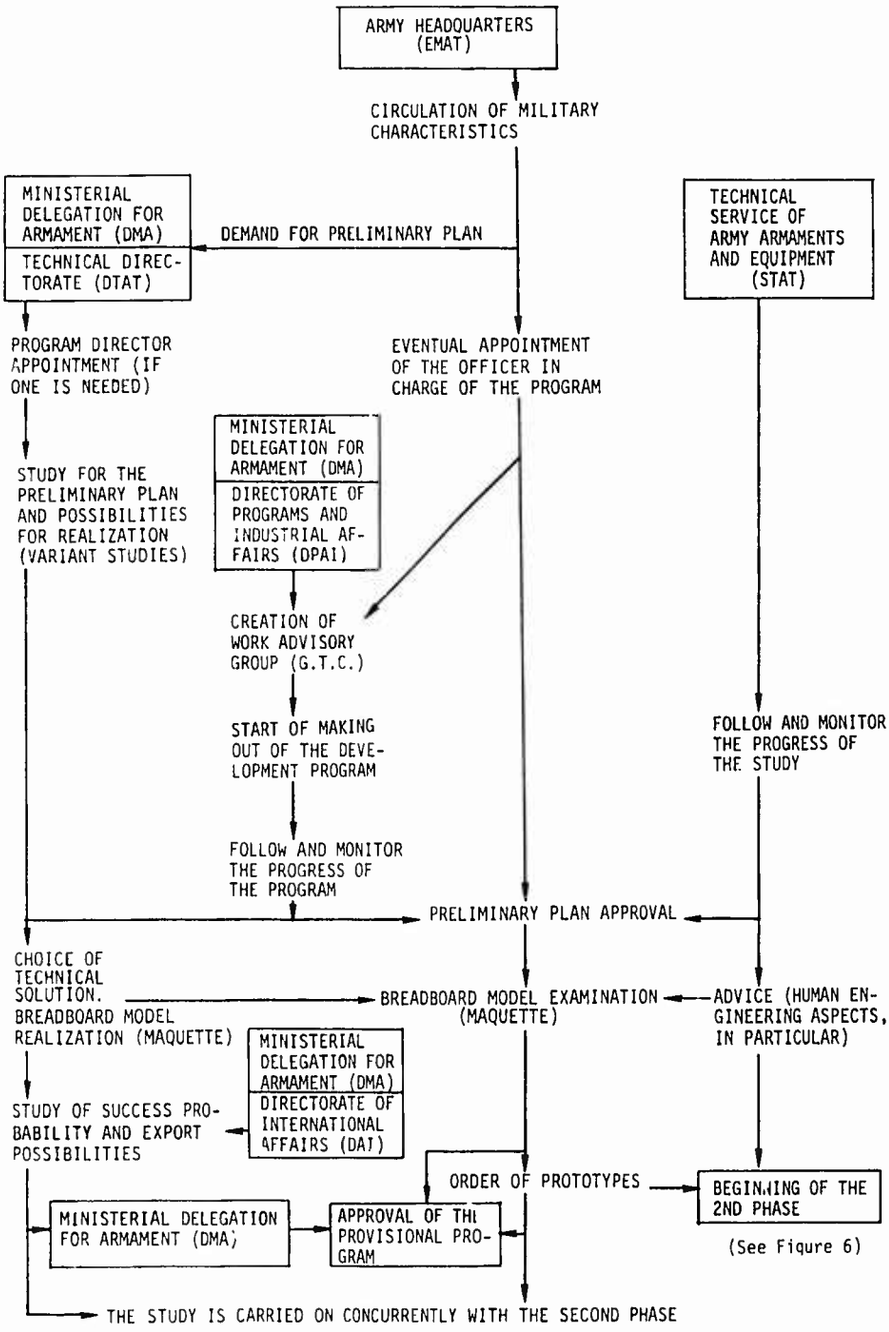


Figure 5. 1st Phase: Program definition–study management.

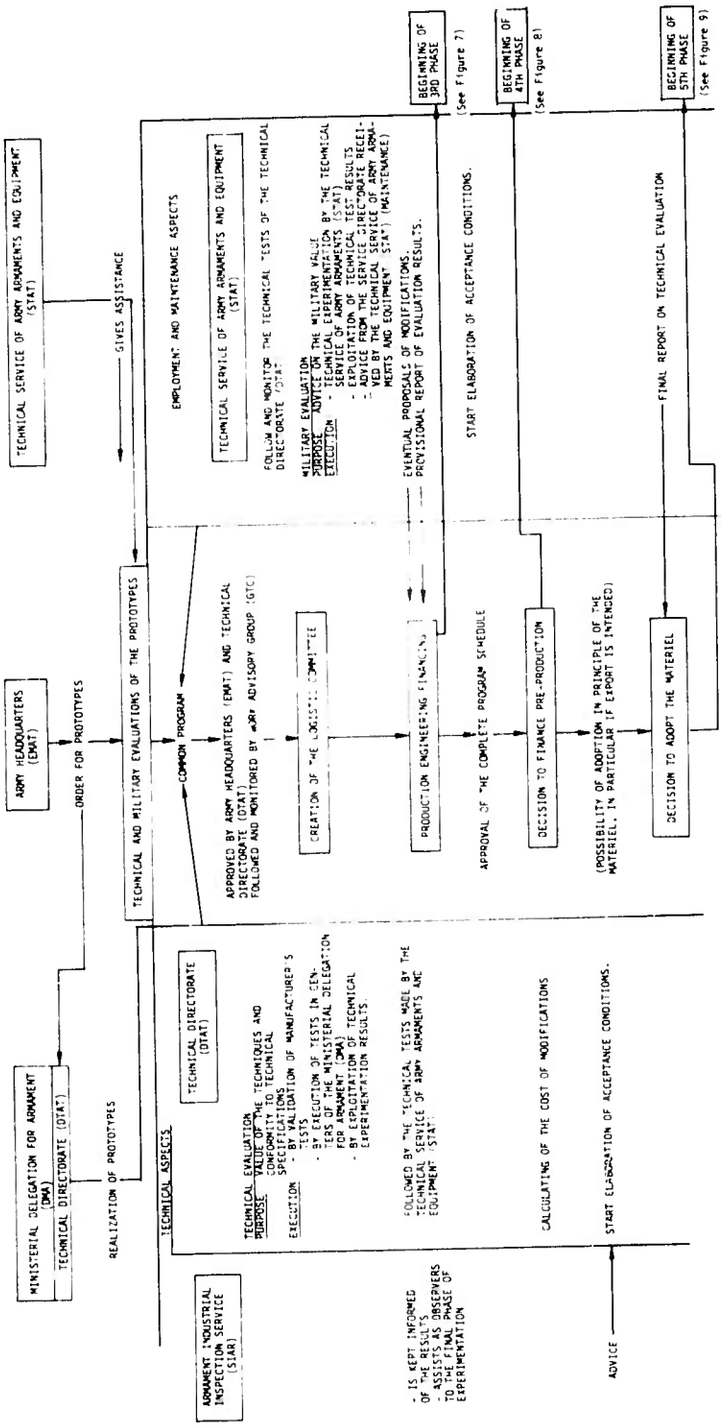


Figure 6. 2nd Phase: Realization, tests, and experimentation of prototypes.

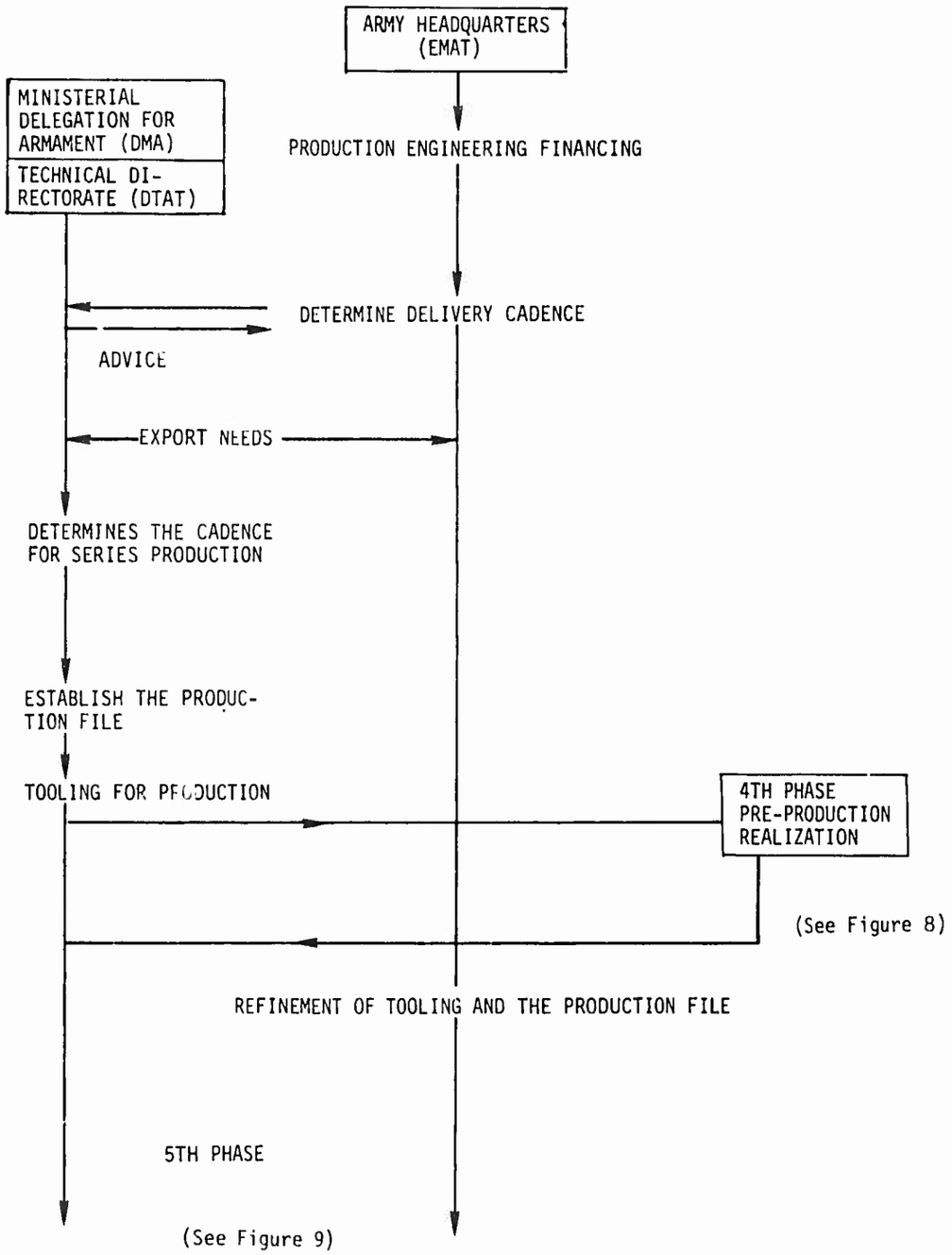


Figure 7. 3rd Phase: Production engineering for manufacturing.

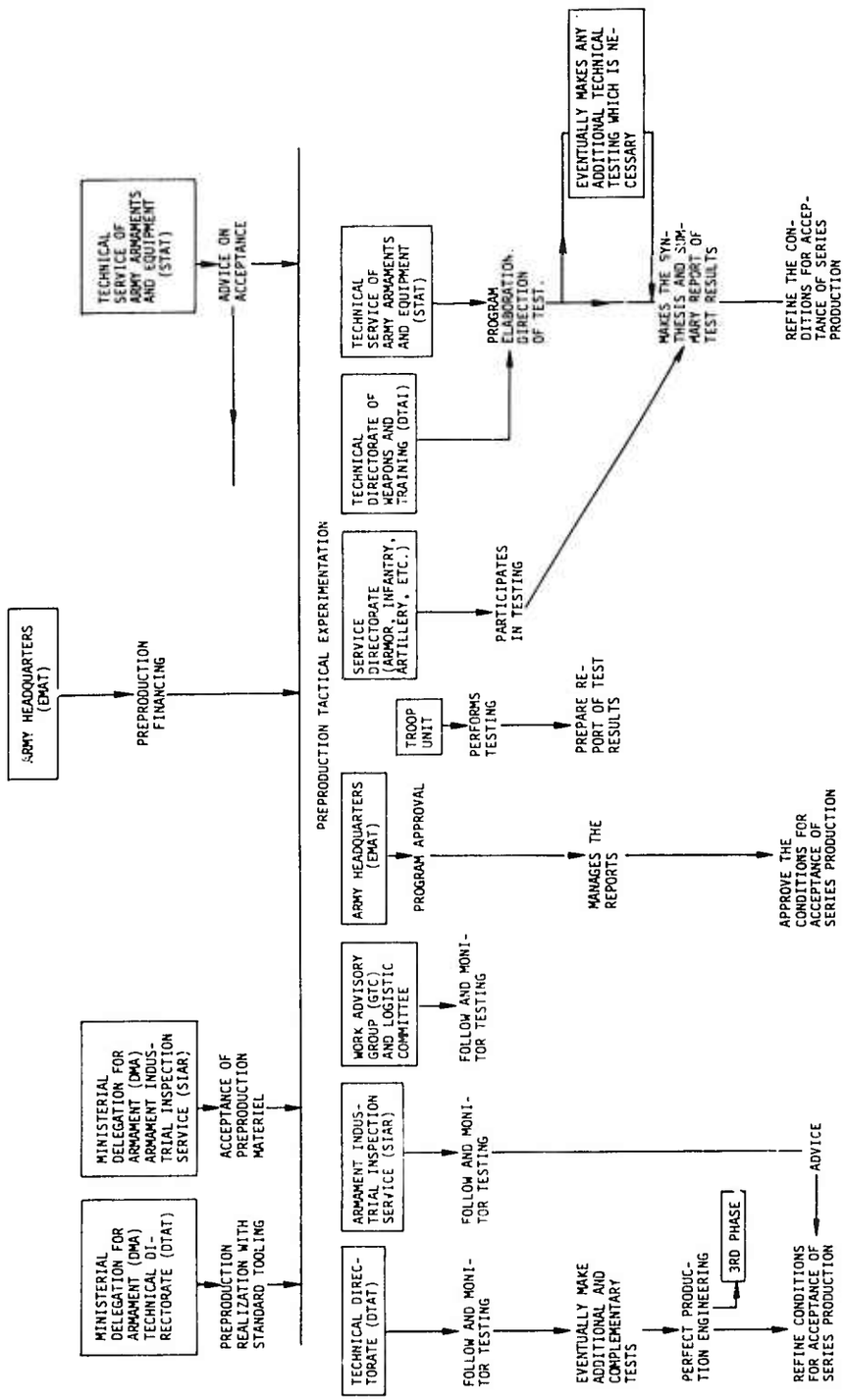


Figure 8. 4th Phase: Preproduction realization and tactical testing.

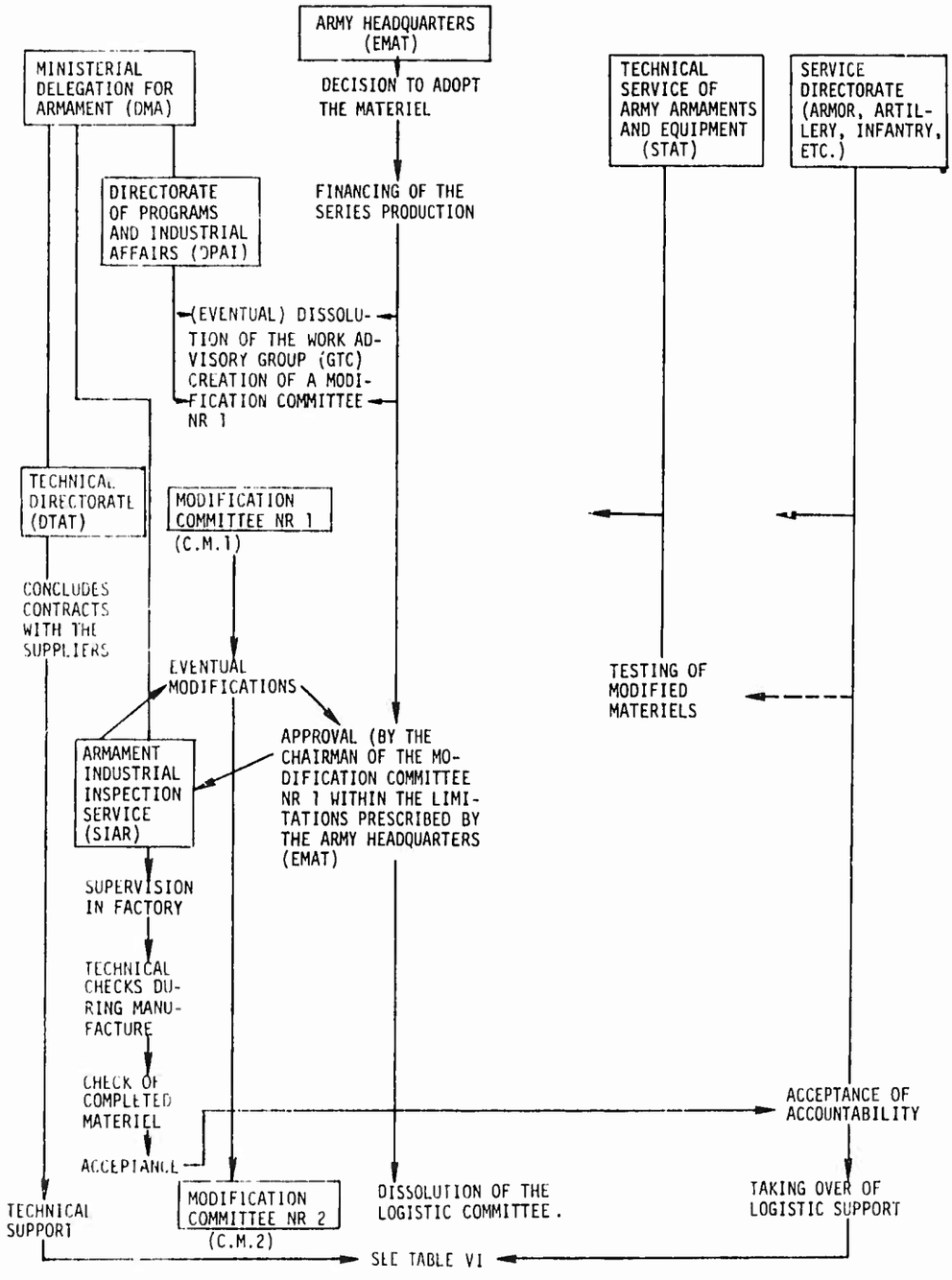


Figure 9. 5th Phase: Production-acceptance-accountability of the service directorate.

Table VI. Placement of New Materiel into Service in Troop Units

Function	Responsible Organization	Remarks
- Organization which is responsible for the management and the placing into service of new materiel.	The Army Headquarters (EMAT) in liaison with the Ministerial Delegation for Armament (DMA) and with the assistance of a work advisory group (G.T.C.) for important materiel.	The Army Headquarters (EMAT) controls the activities of the Logistic Committee.
- Preparation of the units, which will receive the first materiel.	- The Army Headquarters (EMAT): - appoints one or several units which are charged with the receipt of the first materiel, - ensures the timely availability and the training of the staff who will be in charge of the operation and maintenance of the equipment.	
- Technical support of operational use.	- In conformance with the agreements for technical assistance established by the Ministerial Delegation for Armament (DMA), the "manufacturer" is charged - under the responsibility and authority of the Technical Directorate concer[illegible] and with the practical participation of the diverse echelons of the Managing Service (2) of support for the first materiel placed in service. This technical support includes in particular: the delivery of the necessary spares, tooling and documents, the dispatch, if need be, of qualified breakdown antennas, the training, by the means of appropriate courses, of the skilled personnel of the units who make use of the materiel and of the Managing Service. "MANUFACTURER" technical support is carried on until the managing Service directorate is able to take charge completely of the materiel and its logistic support.	1. Technical Directorate responsible for the materiel or civil manufacture. 2. User representatives to the Technical Directorate.
- Take charge of the logistic support for the new materiel.	the day when the Service Directorate takes charge of the logistic support is fixed by the Army Headquarters (EMAT) at a time determined by the Logistic Committee.	
	Note: The fact that the take-over of logistic support by the Service Directorate is delayed in relation to the placing into service of the first materiel, does not change at all the modalities for the acceptance of accountability for the materiel and of the first allowance issues for maintenance. *Technical support initially as[illegible]sured by the manuf[illegible] which should in no case disturb the normal management of the [illegible]riel and maintenance allowances for which the Service Directorate regularly accepts accountability.*	

LIST OF ABBREVIATIONS

Acronym	French	English
ALM	Atelier de Fabrication du Mans	Mans Factory
AMX	Atelier de Construction d'Issy-les-Moulineaux	Issy-les-Moulineaux Factory
APX	Atelier de Construction de Puteaux	Puteaux Factory
ARE	Atelier de Construction de Roanne	Roane Factory
ATS	Atelier de Construction de Tarbes	Tarbes Factory
CAEPE	--------	Propellant and Missile Test Center (St. Medard en Jalles)
CAP	--------	Toulouse Airborne Test Center
CASDN	--------	Scientific Action Committee of National Defense
CEA	Commissariat a l'Energie Atomique	Atomic Energy Commission
CEAT	--------	Aviation Test Center (Toulouse)
CEDOCAR	--------	Armament Documentation Center
CEL	--------	Landes Test Center
CEPR	--------	Propulsion Test Center (Saclay)
CEV	--------	Flight Test Center (Bretigny sur Orge)
CII	Compagnie Internationale pour l'Informatique	--------
CIRO	--------	Joint Center of Operational Research
CPE	--------	Center for Research and Development Prospects and Evolution
CTPA	--------	Technical Committee for Armament Programs
DAI	Direction des Affaires Internationales	Directorate of International Affairs
DEA	--------	Data Exchange Agreements
DI	Delegation a l'Informatique	--------

Acronym	French	English
DMA	Delegation Ministerielle pour l'Armement	Ministerial Delegation for Armament
DPAG	Direction des Personnels et Affaires Generales	Directorate of Personnel and General Affairs
DPAI	Direction des Programmes et Affairs Industrielles	Directorate for Programs and Industrial Affairs
DRME	Direction des Recherches et Moyens d'Essais	Directorate for Research, Development, and Testing
DTAT	Direction Technique des Armements Terrestres	Technical Directorate for Ground Armaments
DTCN	Direction Technique des Constructions Navales	Technical Directorate of Construction, Naval
DTEn	Direction Technique des Engins	Technical Directorate for Missiles
EFAB	Establissement d'Etudes et Fabrications d'Armement de Bourges	Bourges Establishment of Armament Research and Manufacture
EM	----------	Service Headquarters
ENSA	----------	Aeronautics School of the Armaments Corps (Toulouse)
ENSTA	----------	National School of Advanced Techniques
GIAT	Groupement Industriel des Armements Terrestres	Ground Armaments Industrial Group
GNP	----------	gross national product
GOF	----------	Government of France
IA	Ingenieurs de l'Armement	Armament Engineers
IETA	Ingenieurs des Etudes et Techniques de l'Armement	Engineers of the Armament Technique and Research Corps
LRBA	----------	Ballistic and Aerodynamic Research Lab (Vernon)
MAS	Manufacture Nationale d'Armes de St-Etienne	National Weapons Plant of St-Etienne
MAT	Manufacture Nationale d'Armes de Tulle	National Weapons Plant of Tulle
MOD	----------	Minister of National Defense
ONERA	Office National d'Etudes et de Recherches Aerospatiales	Office of Aerospace Studies and Research
R&D	----------	Research and Development
SAGEM	Societe d'Applications Generales d'Electricite et de Mecanique	----------

Acronym	French	English
SCTI	Service Central des Telecommunications et de l'Informatique	Central Service Telecommunications and Automatic Data Processing
SEBC	-------	Bouchet Biological and Chemical Studies Center
SEREB	Societe d'Etudes et de Recherches d'Engins Balistiques	-------
SFENA	Societe Francaise d'Equipements pour le Navigation Aerienne	-------
SFIM	Societe de Fabrication d'Instruments de Mesure	-------
SIAR	-------	Service of Industrial Surveillance for Armament
SIPRI	-------	Stockholm International Peace Research Institute
SSBM	-------	Surface-to-Surface Ballistic Missile
SSBN	-------	Nuclear Missile Submarine
STPE	-------	Technical Service for Powder and Explosives

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